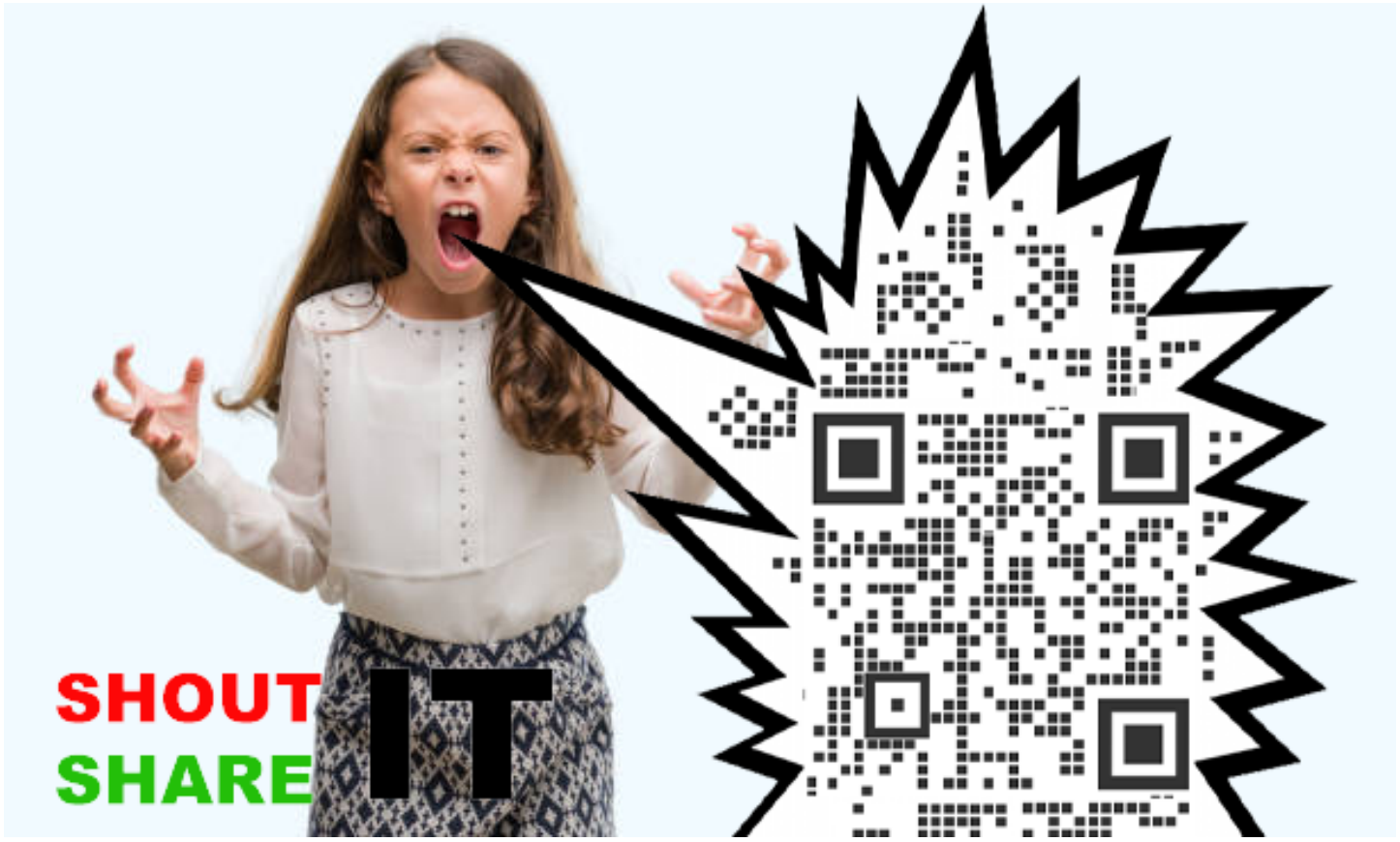

SHOUT
SHARE
IT

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices

UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 798

Contribution from the Bureau of Soils
MILTON WHITNEY, Chief

Washington, D. C. ▼ October 20, 1919

A SURVEY OF THE FERTILIZER INDUSTRY.

Prepared under the direction of Wm. Wallace Mein, Assistant to the Secretary in Charge of Fertilizer Control.

By E. A. Goldenweiser, *Statistician.*

CONTENTS.

	Page.		Page.
Introduction	1	Production of mixed fertilizers	13
Materials used in mixed fertilizers	2	Stocks	16
Sulphuric acid and acid phosphate	4	Imports and exports	18
Sources of nitrogenous materials	7	Reference list	26
Potash-bearing materials	12		

INTRODUCTION.

The Fertilizer Control was created under authority of the food control act as a war emergency measure in the Department of Agriculture. Soon after its establishment this office undertook a survey of the fertilizer industry in order to determine the materials used, the products, and the stocks of ingredients and of mixed goods on hand. In view of a serious shortage of several of the materials that enter into the manufacture of fertilizer, it was deemed important to ascertain what the requirements of the industry were, in order to stimulate production of the scarce ingredients, and, if it became necessary, to apportion the available supply of scarce materials on an equitable basis. A series of questionnaires was sent out by the office of Fertilizer Control. The information collected is for the calendar years 1917 and 1918. In the case of fertilizer manufacturers a schedule was first obtained for 1917 and the first six months of 1918, and then another schedule was sent out to cover the last six months of 1918. Data on phosphate rock were obtained for 1918, information for 1917 having been collected by the Bureau of Soils. A potash schedule was sent out later in the year, and called for reports for

127491°—19—Bull. 798——1

1917, for the first nine months of 1918, and for estimates for the remaining three months of 1918. A schedule for tankage producers was sent out toward the end of the year, and called for reports for the two calendar years 1917 and 1918. Data are thus available for a study of the fertilizer industry during two years, both of which were war years. No comparison with prewar years can be made, for lack of data, but a future survey of the industry in years after war activities have ceased will afford interesting comparisons.

MATERIALS USED IN MIXED FERTILIZERS.

Table I shows the amount of materials of different kinds used in the manufacture of mixed fertilizers during the years 1917 and 1918.

TABLE I.—*Materials used in producing fertilizer as reported by fertilizer manufacturers.*

[2,000-pound tons.]

Kind of material.	1917	1918	Kind of material.	1917	1918
Agricultural lime	32,602	40,252	Nitrogenous materials—Con.		
Agricultural salt	2,474	2,650	Ammonium phosphate	20,237	7,096
Acid phosphate	3,746,693	[1] 3,554,000	Tankage:		
Potash materials:			Animal tankage (high grade)	185,491	134,446
Potassium sulphate	13,420	16,808	Animal tankage (low grade)	108,775	82,209
Potassium muriate	12,124	19,189	Garbage tankage	123,835	96,142
Potassium nitrate	14,478	17,286	Tankage (n. o. s.)	5,994	4,770
Potassium carbonate	7,656	5,706	Dried blood	37,189	25,799
Kainite	2,175	368	Cottonseed meal	306,399	273,876
Manure salts	1,684	194	Fish scrap (dried)	28,769	28,813
Nebraska potash	7,201	18,815	Fish scrap (acidulated)	17,234	24,215
Cement dust	6,489	6,301	Castor bean pomace	19,948	36,481
Furnace dust	8,499	12,105	Hair	9,254	7,179
Roasted alunite	667	1,999	Hoof meal	6,340	5,681
Kelp (dried)	3,064	4,777	Horns	200	74
Kelp (ash)	2,929	3,722	Hide scrap	218	921
Kelp (char)	16	348	Leather scrap or meal	18,078	13,892
Tobacco waste	37,218	30,816	Leather (acidulated)	75	.....
Wood ash and other plant ash	6,523	7,458	Wool waste	1,135	1,002
Manure ash	2,197	2,768	Tartar pomace	2,709	2,893
Feldspar	601	134	Peat (dried)	742	1,892
Sugar factory waste	5,071	5,250	Natural guano	67,715	52,549
Other potash materials	33,863	34,898	Base goods	518,378	502,132
Nitrogenous materials:			Other nitrogenous materials	39,162	29,259
Sodium nitrate	285,983	234,794	Filler	161,932	216,764
Ammonium sulphate	125,283	103,356	Other materials (n. o. s.)	6,986	11,294
Cyanamid	37,230	6,099			
Nitrate of lime	33	595			

[1] Partly estimated.

The figures for 1918 are not altogether comparable with those for 1917, as 55 companies included in the tabulation for 1917 and for the first six months of 1918 failed to make reports for the last six months of 1918. In the case of acid phosphate an estimate has been made to cover the companies for which reports were not received for July to December, 1918.

The principal kinds of material reported are acid phosphate (the chief carrier of phosphoric acid), potash-bearing materials, and nitrogenous materials. A certain quantity of agricultural lime, agricultural salt, and filler was also reported, and a comparatively small

quantity of other materials which it was not possible to classify. It is probable that the figures for filler are not complete, as the schedule did not specifically ask for it, and many of the firms doubtless neglected to report the quantities used, and the same is likely to be true of the agricultural salt and possibly of the lime. In connection with the reported quantity of filler, it should be kept in mind that the filler used in the preparation of mixed fertilizer is only a small part of the inert matter in the product. In the manufacture of mixed fertilizer, filler is used largely for the purpose of obtaining the desired grade or composition in the mixed goods. A concrete example may help to make this proposition clear. If it is desired to make a mixture containing 2 per cent of ammonia, 8 per cent of phosphoric acid and 2 per cent of potash (the well-known grade, 2–8–2) and the materials at hand are cottonseed meal, containing 7 per cent of ammonia, acid phosphate, containiug 16 per cent of phosphoric acid, and Nebraska potash, containing 28 per cent of potash, the method of making up the mixture will be as follows: 2 per cent of a 2,000-pound ton is 40 pounds; in order to obtain 40 pounds of ammonia from 7 per cent cottonseed meal it will be necessary to use 571 pounds of cottonseed meal. The amount of phosphoric acid desired is 8 per cent of a ton or, in fertilizer parlance, 8 units, or 160 pounds. To obtain 160 pounds from a 16 per cent acid phosphate will require 1,000 pounds of acid phosphate. The amount of potash called for is 40 pounds and to obtain that from a 28 per cent material, 143 pounds will be required. The total amount of materials used, therefore, will be 571 plus 1,000 plus 143, or 1,714 pounds. To this are added 286 pounds of filler in order to make up the ton.

It will be seen from the foregoing statement that filler has not only a legitimate but a necessary use in the preparation of mixed fertilizer under the existing methods of manufacture. While it is likely that in the 5 million tons of fertilizer produced during 1918 more than 217,000 tons of filler were used, the filler constituted only a small proportion of the inert matter in the mixture. Thus, in the example given, the 2,000-pound ton contained 286 pounds of filler, while the total of inert matter was as follows: Of the 571 pounds of cottonseed meal, 531 pounds were inert; of the 1,000 pounds of acid phosphate, 840 pounds were inert; and of the 143 pounds of Nebraska potash, 103 pounds were inert; so that the total inert matter in the plant food bearing materials was 1,474 pounds; and the ton of fertilizer consisted of 240 pounds of plant food, 1,474 pounds of inert matter in the plant food bearing materials, and 286 pounds of filler.

The fact that from three-fourths to seven-eighths of the mixed fertilizer sold to farmers consists of inert matter which does not contribute to the fertility of the soil, but on which freight must be

paid and which must be ground and bagged and transported, is one of the fundamentals in the fertilizer industry. If a means were devised by which farmers could buy practically undiluted plant food and make up their own mixtures, an enormous saving would be effected, and any method that would decrease the amount of inert matter carried in fertilizers would be of great benefit to the agriculture of the country. The quantity of filler used is only a minor phase of this problem, but perhaps the part of it which is most easily susceptible of improvement while the present general methods prevail in the industry.

SULPHURIC ACID AND ACID PHOSPHATE.

Some of the fertilizer manufacturers produce their own sulphuric acid, while others buy sulphuric acid. Of the 425 companies for which this office secured returns, 68 were producers of sulphuric acid. These firms used the quantities of pyrites and sulphur shown in Table II in the production of sulphuric acid for the periods to which the schedule refers:

TABLE II.—*Materials used in the manufacture of sulphuric acid.*

[2,000-pound tons.]

Material.	1917.	January to June inclusive, 1918.
Pyrites	585,317	244,154
Sulphur	104,556	85,625

The proportion of sulphur used during the first six months of 1918 was much greater than the corresponding proportion during 1917. In pre-war times Spanish pyrites was practically the only source of sulphuric acid, as pure sulphur was too expensive to be used in the manufacture of the acid, but owing to lack of shipping facilities, caused by the war, it became very difficult to obtain pyrites from Spain; on the other hand, the price of sulphuric acid advanced decidedly as a result of the demand for the acid by manufacturers of munitions, so that it became profitable to make the acid out of pure sulphur. Domestic and Canadian sources of pyrites were utilized, but they were not sufficient to supply the demand. In addition to sulphur and pyrites, a certain amount of nitrate of soda is used in the manufacture of sulphuric acid, but the schedules did not call for the uses to which nitrate of soda was put, and there is no way of determining how much was used in connection with the acid chambers and how much went into mixed fertilizers. Beginning with July, 1918, the Nitrate Committee of the

War Industries Board did not permit fertilizer manufacturers to have any nitrate of soda for mixing, and allowed them only enough for the manufacture of sulphuric acid, estimating roughly that their requirements of nitrate of soda amounted to about 1 per cent of their total sulphuric acid production.

Most of the large fertilizer companies make their own acid phosphate. Such firms are known as wet mixers, of whom 104 reported. Table III shows the quantity of material used in the manufacture of acid phosphate during 1917 and during the first six months of 1918.

TABLE III.—*Material used in the production of acid phosphate.*

[2,000 pound tons.]

Material.	1917.	January to June inclusive, 1918.
Phosphate rock	2,206,523	1,172,124
Steamed ground bone	71,925	33,196
Raw ground bone	31,657	22,667
Bone black	986	600
Basic slag	128	77
Other phosphatic materials	484	326
Sulphuric acid	2,135,113	1,068,464

The companies used more than 2,200,000 tons of phosphate rock in the manufacture of acid phosphate during 1917, as compared with only 72,000 tons of steamed ground bone, and 32,000 tons of raw ground bone with small quantities of other phosphatic materials. The quantity of sulphuric acid used is approximately the same as that of the phosphorus-bearing materials.

The production of phosphate rock was conducted by a number of the fertilizer companies and by other producers, mostly in Florida. Many of the big fertilizer companies are interested in the phosphate fields and are producing their own rock. The total production of phosphate rock amounted to 2,696,000 short tons, in 1918, as compared with 2,588,000 short tons in 1917. The 1918 total is analyzed in Table IV.

TABLE IV.—*Phosphate rock produced in 1918.*

[2,000-pound tons.]

Kind of rock.	Short tons.	Kind of rock.	Short tons.
Total	2,695,543	Tennessee:	
		Brown rock	377,511
Florida:		Blue rock	52,777
Hard rock	42,840	South Carolina	51,387
Soft phosphate	17,736	Utah	1,532
Land pebble	2,141,950	Idaho	3,211
		Kentucky	6,599

The greatest production was of Florida land pebble (2,142,000 tons), which alone comprised about four-fifths of the entire output. Tennessee brown rock, of which 378,000 tons were mined, is next in

importance. The production of but two of the other kinds amounted to 50,000 tons.

Table V shows the quantity of phosphate rock marketed in the United States during the six months from January to June, 1918, distinguishing between the amount that was used in the manufacture of acid phosphate and the amount that was sold directly to farmers for application to the soil. It also shows the quantity exported and the stocks on hand at three given dates.

TABLE V.—*Phosphate rock marketed January–June, 1918, and stocks on hand Jan. 1, 1917 and 1918, and June 30, 1918.*

[2,000-pound tons.]

Kind of rock.	Quantity marketed in United States January–June, 1918.		Quantity exported January–June, 1918.	Stocks on hand.		
	To acid phosphate manufacturers.	To farmers for direct application.		Jan. 1, 1917.	Jan. 1, 1918.	June 30, 1918.
Total	805,735	65,225	27,664	713,290	974,564	944,665
Florida:						
Hard rock	.....	.....	2,732	174,530	220,824	228,162
Soft phosphate	58	6,559	1,002	326	370	170
Land pebble	706,935	45,203	21,385	499,407	748,243	708,780
Tennessee:						
Brown rock	93,854	11,364	2,545	39,020	5,121	7,547
Blue rock	587	2,100	.....	.....	.....	.....
South Carolina	22	.....	.....	7	6	6
Utah	1,061	.....	.....	.....	.....	.....
Idaho	3,211	.....	.....	.....	.....	.....
Kentucky	7	.....	.....	.....	.....	.....

The great mass of the rock marketed during the period under discussion was in the form of Florida land pebble, of which 774,000 tons were marketed during the first six months of 1918, and the next most important quantity was of Tennessee brown rock. It should be noted that most of the rock is sold to manufacturers of acid phosphate, and that only small quantities, amounting to about 7 per cent of the total marketed in the United States, are sold to farmers for direct application to the soil. The exports for the six months of 1918 were very small, owing to the difficulty of obtaining cargo space. A notable fact is that the accumulation of phosphate rock in the hands of the mining companies is large. Very little hard rock was produced during the first six months of 1918, and the small quantity produced was exported, but a very considerable amount of that rock, more than 200,000 tons, was in stock. The stocks of the Florida land pebble rock were large and increased from 499,000 tons at the beginning of 1917 to 748,000 tons at the beginning of 1918, but declined somewhat during the six months period, January–June, 1918.

SOURCES OF NITROGENOUS MATERIALS.

Table VI and a graph (fig. 1) show the sources of ammonia used in mixed fertilizers. The table shows the total amount of each material used, as reported by the fertilizer manufacturers, the average ammonia content, the total quantity of ammonia in each material, and the proportion of the total ammonia derived from each source.

TABLE VI.—*Sources of ammonia in mixed fertilizer.*

Material.	Average per cent of ammonia.	Quantity of material used (2,000-pound tons).		Units of ammonia in materials used (unit =20 pounds).		Percentage of ammonia from each source.	
		1917	1918	1917	1918	1917	1918
All sources				18,620,200	15,039,300	100	100
Sodium nitrate	18.8	285,983	234,794	5,376,500	4,414,100	28.9	29.4
Ammonium sulphate	24.3	125,283	103,356	3,044,400	2,511,600	16.3	16.7
Cyanamid	15.6	37,230	6,099	580,800	95,100	3.1	.6
Nitrate of lime	15.6	33	595	500	9,300	.....	.1
Ammonium phosphate	13.0	20,237	7,098	263,100	92,300	1.4	.6
Tankage:							
Animal (high grade)	11.0	185,491	134,446	2,040,400	1,478,900	11.0	9.8
Animal (low grade)	7.0	108,775	82,209	761,400	575,500	4.1	3.8
Garbage	3.3	123,835	96,142	408,700	317,300	2.2	2.1
Tankage (n. o. s.)	6.3	5,994	4,770	37,800	30,100	.2	.2
Dried blood	13.8	37,189	25,799	513,200	356,000	2.8	2.4
Cottonseed meal	8.4	306,399	273,876	2,573,800	2,300,600	13.8	15.3
Fish scrap (dried)	9.0	28,769	28,813	258,900	259,300	1.4	1.7
Fish scrap (acidulated)	6.0	17,234	24,215	103,400	145,300	.6	1.0
Castor bean pomace	6.6	19,948	36,481	131,700	240,800	.7	1.6
Hair	18.0	9,254	7,179	166,600	129,200	.9	.9
Hoof meal	15.0	6,340	5,681	95,100	85,200	.5	.6
Horns	15.0	200	74	3,000	1,100	.....	.....
Hide scrap	12.0	218	921	2,600	11,100	.....	.1
Acidulated leather	9.0	75	.....	700	.....	.....	.....
Leather scrap or meal	13.0	18,078	13,892	235,000	180,600	1.3	1.2
Wool waste	7.0	1,135	1,002	7,900	7,000	.....	.....
Tartar pomace	.9	2,709	2,893	2,400	2,600	.....	.....
Peat (dried)	1.5	742	1,892	1,100	2,800	.....	.....
Natural guano	7.8	67,715	52,549	528,200	409,900	2.8	2.7
Base goods	2.4	518,378	502,132	1,244,100	1,205,100	6.7	8.0
Other nitrogenous materials	6.1	39,162	29,259	238,900	178,500	1.3	1.2

The total amount of ammonia used during 1917 was more than 18,600,000 units of 20 pounds, and the total amount used during 1918 exceeded 15,000,000 units.

The principal source of ammonia during both years for which data were obtained was sodium nitrate, nearly 30 per cent of the ammonia being derived from that one source.

The second source in importance was ammonium sulphate, from which about one-sixth of the ammonia was derived.

Among the organic sources of ammonia, tankage and cottonseed meal are by far the most important. The proportion of ammonia derived from animal tankage of high and of low grade was less in 1918 than in 1917, owing, probably, to the great demand for tankage as feed. The proportion derived from cottonseed meal increased from 13.8 per cent in 1917 to 15.3 per cent in 1918.

Nearly four-fifths of the ammonia in fertilizers is thus derived from the two great mineral sources, sodium nitrate and ammonium sulphate, together with the two principal organic sources, tankage and cottonseed meal.

The only other important source of ammonia reported is "base goods," a designation which indicates that the original source is not given, base goods being a name by which the companies call preliminary mixtures which are stored in large bins against the time when orders need to be filled and the base goods are mixed with other ingredients to obtain a desired grade of goods.

Other sources of ammonia worth mentioning are cyanamid, which yielded 581,000 units of ammonia in 1917 but only 95,000 units in 1918, owing to the fact that this material was requisitioned by the Ordnance Department; and dried blood, which accounted for 2.8 per cent and 2.4 per cent, respectively, during 1917 and 1918.

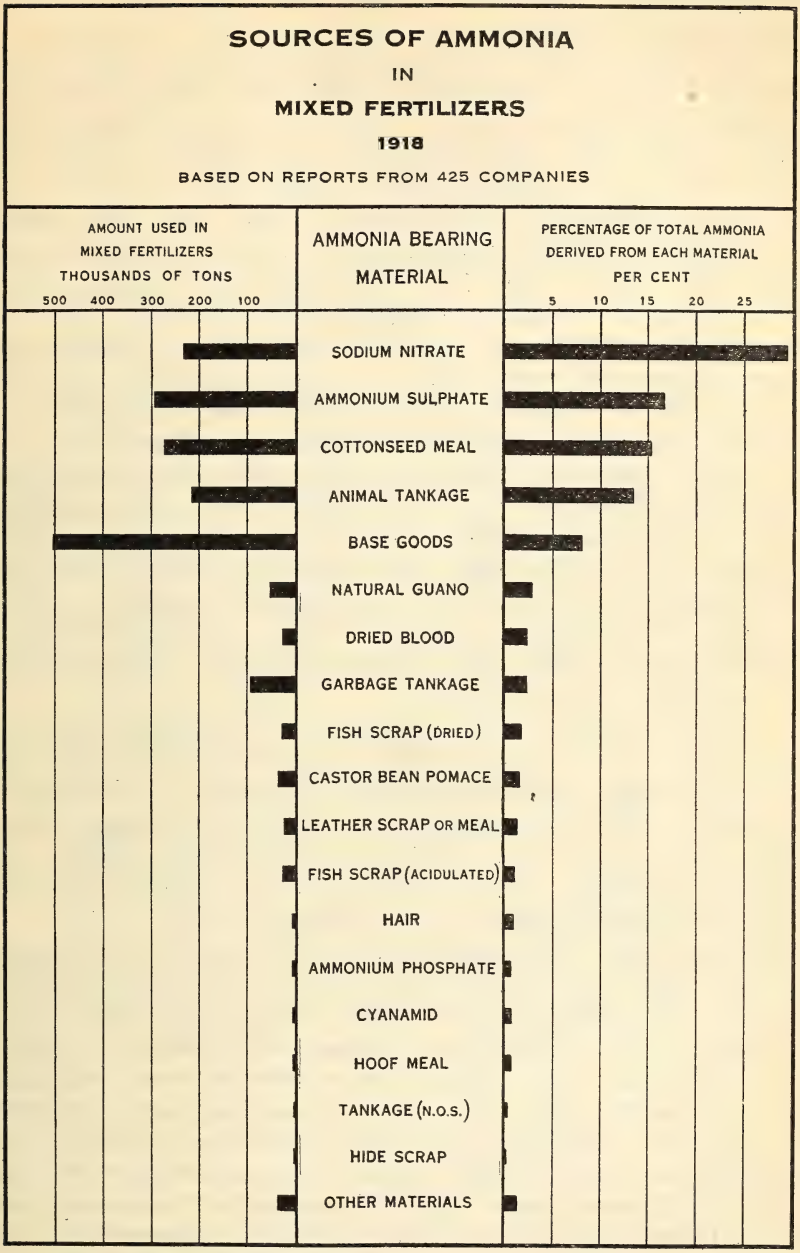
Tankage.—A special inquiry about the amount of tankage produced was sent out by the office of Fertilizer Control, and returns from 503 packers and renderers were received. Table VII shows the total quantity of tankage and allied materials produced during 1917 and 1918, and the quantity marketed in 1918 to be used as fertilizer, to be used for feed, and for other purposes.

TABLE VII.—*Tankage and allied products produced in 1917 and 1918 and marketed in 1918.*

Kind of material.	Production, 503 firms reporting (2,000-pound tons).		Quantity marketed in 1918, 386 firms reporting (2,000-pound tons).				Percentage marketed, 1918.		
	1917	1918	Total.	As fertilizer.	As feed.	For other purposes.	As fertilizer.	As feed.	For other purposes.
Animal tankage (high grade)	157,300	185,839	182,320	103,703	78,187	430	56.9	42.9	0.2
Animal tankage (low grade)	59,604	64,614	62,805	56,239	5,213	1,354	89.5	8.3	2.2
Concentrated tankage	24,674	25,490	26,098	16,540	9,481	77	63.4	36.3	.3
Garbage tankage	36,997	34,718	28,598	28,598	.....	.....	100	.....	.....
Tankage (n. o. s.)	7,750	10,004	3,732	3,122	58	552	83.7	1.6	14.7
Dried blood	32,007	35,403	32,578	26,918	5,671	.....	83.6	1.5	14.9
Raw bones	27,981	33,644	26,451	22,607	3,281	862	82.6	17.4	.....
Dried bones	24,348	21,475	20,158	20,093	5	60	85.5	12.3	3.2
Hair	5,617	8,754	4,638	1,941	.....	2,698	41.8	.....	58.2
Hoofs and horns	6,715	4,671	4,008	3,539	386	83	88.3	9.6	2.1
Meat scrap	3,265	3,233	3,561	.....	3,549	11	.....	99.7	.3

The 503 firms for which returns were received produced 157,000 tons of high-grade tankage in 1917 and 186,000 tons in 1918. The quantity of low-grade tankage was about one-third of the amount of high-grade tankage, and in addition there were about 25,000 tons of concentrated tankage in each of the two years 1917 and 1918, and about 35,000 tons of garbage tankage, with a certain amount of tankage the character and quality of which were not

FIGURE 1.



127491°—19—Bull. 798——2

indicated. Dried blood and raw and dried bones were the other important items. The amount of hair, hoof, and horns, and meat scrap was not very large.

Of the 503 firms from which reports were received, 386 reported sufficient data on the purposes for which their products were used to make a tabulation possible. While less than four-fifths of the firms reported that information, the quantities for which they reported were a very large proportion of the total. In some cases the amount marketed was somewhat greater than the amount produced, which probably means that an additional amount was sold from stock. About 57 per cent of the high-grade animal tankage was marketed as fertilizer and about 43 per cent as feed. If these percentages are representative, they indicate one of the reasons that animal ammoniates were difficult to secure during the year 1918. Of the low-grade tankage, however, 89.5 per cent was marketed as fertilizer, while of the concentrated tankage nearly two-thirds was so marketed, and of the garbage tankage the entire amount was disposed of as fertilizer. In the case of dried blood, more than four-fifths was marketed as fertilizer, and of the raw bones even a higher proportion, while of the dried bones nearly the entire amount was used as fertilizer, and of the hoofs and horns seven-eighths. About two-fifths of the hair was used as fertilizer, the remainder being used for purposes other than fertilizer or feed. The meat scrap was practically all used for feed.

A special investigation was conducted by the Food Administration, in cooperation with the Office of Fertilizer Control, covering all the reduction plants, municipal or otherwise. According to the returns of that investigation, which were very complete, these plants produced, in 1917, 168,000 tons of garbage tankage, and in 1918, 159,000 tons. The recovery per ton of garbage was 262 pounds of tankage in 1917 and 286 pounds in 1918.

Cottonseed meal.—In connection with cottonseed meal, an inquiry was made from all the mills that manufacture cottonseed oil and meal as to the amount produced during the fiscal year July 1, 1917, to June 30, 1918, and the amount disposed of for different purposes and in different ways. Returns were received from 506 mills having a total production of cottonseed meal and cake of 1,600,000 tons, or about four-fifths of the total production, which was for this period, as reported by the Census Bureau, about 2,000,000 tons.

Table VIII shows that of the total quantity of cottonseed meal produced about 4 per cent was used by the mills themselves in the manufacture of fertilizer. About 400,000 tons were sold direct to farmers, while the remainder was shipped to other points. Of the quantity sold to farmers, nearly equal proportions were used as feed and as fertilizer, while a very large proportion of the material that

was shipped to other points was used as feed. This may be due to the fact that in order to be able to pay freight on cottonseed meal it is necessary to utilize it in the most efficient way. It is also probably true that the meal shipped away was of a higher grade than that used in the immediate vicinity of the oil mill.

TABLE VIII.—*Production and disposal of cottonseed meal and cake, by States, July 1, 1917, to June 30, 1918.*

AMOUNTS IN 2,000-POUND TONS.

State.	Number of mills reporting.	Total tons of cottonseed meal and cake produced.	Quantity used by mills in the manufacture of fertilizer.	Quantity sold to farmers to be used as—		Quantity shipped to other points to be used as—		Undistributed.
				Feed.	Fertilizer.	Feed.	Fertilizer.	
Total for 16 States	506	1,616,617	62,656	186,952	200,905	756,581	243,625	165,898
Alabama	41	78,352	4,738	8,107	6,210	26,645	12,424	20,228
Arizona	3	6,597	.....	2,406	.....	4,191	.....	.....
Arkansas	32	137,633	3,226	14,510	3,305	104,690	8,614	3,288
California	1	7,327	.....	.....	.....	7,327	.....	.....
Florida	3	6,692	.....	160	440	4,025	2,067	.....
Georgia	107	346,603	23,691	29,879	52,781	114,786	71,638	53,828
Illinois	1	3,781	.....	300	.....	3,481	.....	.....
Kentucky	1	5,173	.....	1,000	.....	3,773	400	.....
Louisiana	25	140,434	427	9,490	8,224	80,671	41,622	.....
Mississippi	48	214,715	6,917	16,718	9,210	140,023	18,841	23,006
Missouri	3	20,130	.....	1,080	.....	19,050	.....	.....
North Carolina	57	129,466	13,049	13,024	42,251	11,985	40,683	8,474
Oklahoma	48	141,282	1,098	43,910	2,080	94,194	.....	.....
South Carolina	75	161,804	9,409	21,748	71,230	15,565	43,852	.....
Tennessee	20	105,368	.....	2,540	4,378	62,199	3,484	32,676
Texas	41	111,260	101	22,080	796	63,976	.....	24,307

PERCENTAGES.

State.	Used by mills in the manufacture of fertilizer.	Sold to farmers to be used as—		Shipped to other points to be used as—		Total percentage used as—	
		Feed.	Fertilizer.	Feed.	Fertilizer.	Feed.	Fertilizer.
Total for 16 States	4.3	12.9	13.8	52.2	16.8	65.1	34.9
Alabama	8.2	13.9	10.7	45.8	21.4	59.7	40.3
Arizona	.....	36.5	.....	63.5	.....	100.0	.....
Arkansas	2.4	10.8	2.5	77.9	6.4	88.7	11.3
California	.....	.....	.....	100.0	.....	100.0	.....
Florida	.....	2.4	6.6	60.1	30.9	62.5	37.5
Georgia	8.1	10.2	18.0	39.2	24.5	49.4	50.6
Illinois	.....	7.9	.....	92.1	.....	100.0	.....
Kentucky	.....	19.3	.....	73.0	7.7	92.3	7.7
Louisiana	.3	6.8	5.9	57.4	29.6	64.2	35.8
Mississippi	3.6	8.7	4.8	73.1	9.8	81.8	18.2
Missouri	.....	5.4	.....	94.6	.....	100.0	.....
North Carolina	10.8	10.8	34.9	9.9	33.6	20.7	79.3
Oklahoma	.8	31.0	1.5	66.7	.....	97.7	2.3
South Carolina	5.8	13.5	44.0	9.6	27.1	23.1	76.9
Tennessee	.....	3.5	6.0	85.7	4.8	89.2	10.8
Texas	.1	25.4	.9	73.6	.....	99.0	1.0

In the aggregate, two-thirds of the cottonseed meal was used as feed and one-third as fertilizer. There is a considerable variation in this respect between the different States. In Arizona, California, Illinois, and Missouri all of the cottonseed meal was reported as being used for feed, and in Oklahoma, Texas, Tennessee, Kentucky, and

Arkansas more than seven-eighths of the cottonseed meal was so used. On the other hand, in the Eastern States a greater proportion was used for fertilizer. The highest proportion used for that purpose was 79.3 per cent in North Carolina, with South Carolina only slightly below that percentage, 76.9 per cent. In Georgia about one-half of the cottonseed meal was used for fertilizer and in Alabama 40 per cent. These are the States that depend on the liberal use of fertilizer for the continuation of their chief industry, which is cotton growing. The farmers in these States find it good economy to return the cottonseed meal to the soil so as to enable it to produce the maximum amount of new cotton plants. It is a characteristic of the cotton plant that comparatively little plant food is removed from the soil provided the seed is returned to the ground.

POTASH-BEARING MATERIALS.

A special schedule was sent to all the producers of potash. The returns on this schedule refer to the years 1917 and 1918. The 1918 returns are based on actual operations for the first nine months and on estimates for the remaining three months. Table IX shows the quantity of potash produced from each of the principal sources and the proportion derived from each source.

TABLE IX.—*Potash produced from the different sources during 1917 and 1918.*

Source.	Quantity of K_2O produced (2,000-pound tons).		Percentage of total K_2O produced from each source.	
	1917	1918	1917	1918
Total from all sources	32,258	53,538	100	100
Mineral sources: Total	25,450	43,820	78.9	81.8
Brines	21,445	38,658	66.5	72.2
Flue dust from blast furnaces	245	303	.8	.6
Cement dust	1,454	2,015	4.5	3.7
Alunite	2,306	2,557	7.1	4.8
Slate	.....	176	.....	.3
Greensand	.....	111	.....	.2
Organic sources: Total	6,808	9,718	21.1	18.2
Kelp	3,372	5,092	10.5	9.5
Tobacco waste	2,006	1,861	6.2	3.5
Beet-sugar factory waste	1,134	2,119	3.5	4.0
Wood ashes	296	646	.9	1.2

The total potash produced during 1918, as reported to this office, including estimates for the last three months, was 53,500 tons, a figure which exceeds by about 1,400 tons the more recent estimates made by the Geological Survey. This difference is probably due in part to the fact that actual production during October, November, and December, 1918, was not as great as had been expected by the producers. The returns, moreover, fail to include potash extracted

from molasses-distillery waste, of which 2,846 tons were produced in 1917 and 3,322 tons in 1918, according to the Geological Survey estimates. When this quantity is added to the above total, the production appears to have been about 57,000 tons. It seems likely, therefore, that the total production for the year fell not less than 3,000 tons, and probably over 5,000 tons, below the estimate of 60,000 tons current during the year. It will be seen that more than four-fifths of the potash is derived from mineral sources and that among these sources lake brines alone account for considerably over two-thirds of the potash. The next most important source in 1918 was kelp, the giant seaweed of the Pacific coast, from which over 5,000 tons of K_2O was derived during the year. Some of the other important sources are alunite, beet-sugar factory waste, cement dust, and tobacco waste.

With the signing of the armistice and the cessation of hostilities the question arose whether the American potash industry which was created by the war emergency will be able to survive under normal conditions. In prewar years the United States consumed about 250,000 tons of potash a year, practically all of which was imported from Germany. When the German supply was cut off in 1914, the United States turned its attention to domestic production, which has increased from year to year, reaching during 1918 the figure of 53,000 tons, or about one-fifth of the annual prewar consumption. Some crops probably have suffered during this period from a lack of potash, but the main needs of the country were supplied in spite of this temporary decline in the consumption of potash. The price of potash rose from between 75 cents and $1 a unit to between $4 and $5 a unit, and even more, and with this great increase in price the domestic manufacturers entered the field of production. Whether they will be able permanently to compete with European potash is an open question.

PRODUCTION OF MIXED FERTILIZERS.

Table X shows the production of mixed fertilizer during 1917 and 1918. It also shows the quantity of acid phosphate and other ingredients sold as such.

TABLE X.—*Production of mixed fertilizer and fertilizer materials sold as such reported by fertilizer manufacturers.*

[2,000-pound tons.]

Kind of material.	1917	1918	Kind of material.	1917	1918
Mixed fertilizer produced	4,442,528	4,957,799	Tankage	8,114	37,827
Materials sold as such:			Blood	3,126	2,304
Acid phosphate	2,097,232	2,024,574	Fish scrap	1,749	1,889
Phosphate rock	393	542	Cottonseed meal	6,682	7,987
Bones:			Natural guano	1,152	6,266
Raw bones	10,023	7,532	Nitrate of soda	7,241	11,334
Steamed bones	698	3,249	Ammonium sulphate	531	2,334
Raw bone meal	11,379	15,707	Cyanamid	117	4
Steamed bone meal	683	1,336			

Of the 2,000,000 tons of acid phosphate reported sold as such, a considerable quantity was sold to dry mixers who used it in preparing the final product. The quantity of acid phosphate used by dry mixers in 1917 was 494,261 tons, leaving about 1,500,000 tons of acid phosphate sold for direct application to the soil. The quantity of mixed fertilizer produced was 4,443,000 tons in 1917 and 4,958,000 tons during 1918. Certain quantities of bone, tankage, blood, fish scrap, and cottonseed meal were sold in their original state; also some nitrate of soda, but beginning with July, 1918, practically no nitrate of soda was sold as such.

Brands.—Each fertilizer manufacturer was asked to give the quantity of each grade of fertilizer he produced during the periods referred to in the schedule; also the names of such fertilizers and the crops for which they were recommended. Table XI gives the quantities of each of the principal grades produced in 1917.

TABLE XI.—*Distribution of fertilizer produced in 1917, by grades.*

Grade.			Quantity produced (2,000-pound tons) in 1917.	Percentage of total production.	Cumulative percentage.	Grade.			Quantity produced (2,000-pound tons) in 1917.	Percentage of total production.	Cumulative percentage.
Total goods for which grade was reported.			3,179,135	100	.....	Total goods for which grade was reported.			3,179,135	100	.....
NH_3	P_2O_5	K_2O				NH_3	P_2O_5	K_2O			
2	10	0	340,664	10.71	10.71	2	9	2	13,356	.42	73.17
3	9	0	193,468	6.08	16.79	1	12	1	12,640	.39	73.56
2	12	0	164,830	5.18	21.97	4	8	3	12,549	.39	73.95
2	8	2	163,756	5.15	27.12	1	7	1	11,605	.36	74.31
4	8	0	137,737	4.33	31.45	3	9	1	11,381	.35	74.66
3	8	0	126,192	3.96	35.41	3½	9	0	11,199	.35	75.01
2	10	2	91,618	2.88	38.29	3	11	0	11,100	.34	75.35
4	10	0	79,749	2.50	40.79	1	8	2	10,956	.34	75.69
5	10	0	74,289	2.33	43.12	3	12	0	10,938	.34	76.03
1	10	0	72,879	2.29	45.41	1	9	0	10,511	.33	76.36
3	8	2	66,830	2.10	47.51	3	5	0	10,419	.32	76.63
3	10	0	54,585	1.71	49.22	1½	9	1	10,340	.32	77.00
1	8	1	54,331	1.70	50.92	1.65	10	0	10,116	.31	77.31
3	8	3	47,546	1.49	52.41	4	8	1	9,956	.31	77.62
2	9	1	43,977	1.38	53.79	½	11	1	9,894	.31	77.93
5	8	0	39,042	1.22	55.01	1	11	0	9,217	.28	78.21
7	8	0	34,307	1.07	56.08	1½	10	0	9,207	.28	78.49
2½	8	1	34,277	1.07	57.15	1	2	1½	9,198	.28	78.77
1	12	0	30,964	.97	58.12	2	11	1	8,814	.27	79.04
2	11	0	30,491	.95	59.07	½	11	½	8,560	.26	79.30
2½	8	0	30,491	.95	60.02	4	12	3	8,500	.26	79.56
4	6	0	27,957	.87	60.89	½	9	1	8,336	.26	79.82
0	16	3	27,769	.87	61.76	7	9	0	8,296	.26	80.08
½	12	0	27,499	.86	62.62	4	12	0	7,960	.25	80.33
3	8	1	26,992	.84	63.46	½	10	0	7,952	.25	80.58
1½	10	0	24,352	.76	64.22	4	7½	0	7,604	.23	80.81
4	8	2	24,137	.75	64.97	3½	10	0	7,412	.23	81.04
4	8	4	21,955	.69	65.66	2½	27	0	7,377	.23	81.27
1	10	1	21,915	.68	66.34	0	10	2	7,273	.22	81.49
2	8	0	21,796	.68	67.02	1¾	7	0	7,162	.22	81.71
1	8	0	20,390	.64	67.66	1.65	11	0	6,931	.21	81.92
2	10	1	19,755	.62	68.28	1	8	3	6,798	.21	82.13
2¾	9	2	19,222	.60	68.88	3	9	2	6,614	.20	82.33
1	9	1	16,960	.53	69.41	5	8	3	6,389	.20	82.53
2¾	8½	1¾	15,906	.50	69.91	4	9	0	6,327	.19	82.72
2	9	0	15,897	.50	70.41	2½	10	0	6,107	.19	82.91
6	7	0	15,816	.49	70.90	½	10	1	5,997	.18	83.09
3	24	0	15,637	.49	71.39	6	10	0	5,888	.18	83.27
1	3	1	15,000	.47	71.86	2	11½	0	5,689	.17	83.44
2	8	1	14,719	.46	72.32	2	8	3	5,559	.17	83.61
5	7	0	13,949	.43	72.75	1	10	½	5,484	.17	83.77

TABLE XI.—*Distribution of fertilizer produced in 1917, by grades*—Continued.

Grade.			Quantity produced (2,000-pound tons) in 1917.	Percentage of total production.	Cumulative percentage.
Total goods for which grade was reported.			3,179,135.	100	.....
NH_3	P_2O_5	K_2O			
½	8	1	5,423	.17	83.95
½	8	0	5,419	.17	84.12
5	6	0	5,298	.16	84.28
6	12	0	5,082	.16	84.43
2	12	¼	5,015	.15	84.58
1	10	5	4,790	.15	84.73
½	8	½	4,761	14	84.87
3	9	3	4,717	.14	85.01
2	7	2	4,711	.14	85.15
4½	9	5	4,685	.14	85.29
6	8	0	4,629	.14	85.43
1	13	20	4,493	.14	85.57
2	9	3	4,522	.14	85.71
2½	12	0	4,391	.13	85.84
½	12	½	4,357	.13	85.97
½	13	1	4,294	.13	86.10
4	7	1	4,254	.13	86.23
2	27	0	4,214	.13	86.36
4	7	3	4,130	.12	86.48
3	10	1	4,049	.12	86.60
1½	19	0	3,979	.12	86.72
1.65	12	0	3,930	.12	86.84
2	8½	1	3,776	.11	86.95
3	5½	0	3,704	.11	87.06
2	10	3	3,662	.11	87.17
½	15	0	3,655	.11	87.28
5	8	2	3,569	.11	87.39
1	14	0	3,496	.10	87.49
5	7	3	3,377	.10	87.59
12	20	0	3,345	.10	87.69
5	7	1	3,343	.10	87.79
1¼	8	0	3,317	.10	87.89
1	8	½	3,275	.10	87.99
1	13	0	3,242	.10	88.09
7	7	0	3,172	.09	88.18
4	11	0	3,074	.09	88.27
2¼	28	0	3,047	.09	88.36
1	23	0	3,002	.09	88.45
1½	12	0	2,942	.09	88.54
5	8	1	2,913	.09	88.63
4	6.07	5	2,850	.08	88.71
1	20	0	2,815	.08	88.79
1½	10	1	2,771	.08	88.87
3	8	½	2,762	.08	88.95
2.9	8	2	2,583	.08	89.03
7	7	3	2,517	.07	89.10
4	9	1	2,508	.07	89.17
5	6	¾	2,507	.07	89.24
5	7	5	2,499	.07	89.31
1	9	2	2,485	.07	89.38
2	8	4	2,469	.07	89.43
2½	8	2	2,432	.07	89.52
3	9	½	2,386	.07	89.59
4	6	3	2,382	.07	89.66
1	¼	10	2,366	.07	89.73
6	7	2	2,361	.07	89.80
4½	8	1	2,310	.07	89.87
4	6	1	2,306	.07	89.94
½	9	½	2,299	.07	90.01
6	6	0	2,289	.07	90.08
4	10	1	2,267	.07	90.15
½	1	10	2,248	.07	90.22
1½	9	0	2,187	.06	90.28
4½	23	0	2,119	.06	90.34
4	6	2	2,118	.06	90.40
2	12	1	2,104	.06	90.46
2	16	0	2,104	.06	90.52
2½	9	0	2,031	.06	90.58
2½	11	0	2,013	.06	90.64
Total goods for which grade was reported.			3,179,135	100	.....
NH_3	P_2O_5	K_2O			
10.09	9.05	0	2,009	.06	90.70
0	12	2	2,005	.06	90.76
4	10	3	2,003	.06	90.82
4	5	0	1,989	.06	90.88
2	10	½	1,959	.06	90.94
2½	8	3	1,945	.06	91.00
1½	30	0	1,917	.06	91.06
1	11	½	1,913	.06	91.12
1	10.18	1	1,891	.05	91.17
7	7	1	1,838	.05	91.22
4½	20	0	1,823	.05	91.27
1	15	1	1,815	.05	91.32
½	8	¼	1,812	.05	91.37
6½	30	0	1,775	.05	91.42
0	12	1	1,764	.05	91.47
5	9	0	1,751	.05	91.52
4	7	0	1,704	.05	91.57
1¼	13	0	1,682	.05	91.62
2	11	½	1,661	.05	91.67
½	50	½	1,655	.05	91.72
5	8	4	1,637	.05	91.77
1¾	9	0	1,620	.05	91.82
¾	15	0	1,617	.05	91.87
½	14	0	1,588	.04	91.91
1½	12	0	1,585	.04	91.95
7	8	1	1,578	.04	91.99
4½	10	0	1,564	.04	92.03
4	7	½	1,562	.04	92.07
2	9½	1½	1,554	.04	92.11
1.65	10½	½	1,553	.04	92.15
1¾	7	1	1,544	.04	92.19
6¼	7	3	1,543	.04	92.23
5.5	5	0	1,524	.04	92.27
2	14	0	1,512	.04	92.31
1.65	12	0	1,506	.04	92.35
8	8½	0	1,462	.04	92.39
3½	20	0	1,453	.04	92.43
5	7	½	1,449	.04	92.47
2	20	0	1,443	.04	92.51
2	8½	1½	1,441	.04	92.55
2	6	3	1,416	.04	92.59
½	8	2	1,395	.04	92.63
3	10	12	1,392	.04	92.67
1¾	9.55	0	1,382	.04	92.71
4½	24	0	1,378	.04	92.75
½	13	½	1,373	.04	92.79
4	9	2	1,348	.04	92.83
1	29	0	1,322	.04	92.87
4½	10½	0	1,310	.04	92.91
5¼	7	0	1,296	.04	92.95
.1	16	.3	1,239	.03	92.98
4	7½	1	1,239	.03	93.01
7	9	1	1,235	.03	93.04
3	12	1	1,212	.03	93.07
1.21	9	1	1,204	.03	93.10
5	6	3	1,197	.03	93.13
½	10	¼	1,176	.03	93.16
8	8	0	1,175	.03	93.19
2¼	13	0	1,150	.03	93.22
1	12	3	1,096	.03	93.25
6.07	10	13	1,068	.03	93.28
4	12	13	1,054	.03	93.31
2½	10	1	1,052	.03	93.34
1¼	10	1	1,045	.03	93.37
5	5	0	1,027	.03	93.40
9	2.17	0	1,000	.03	93.43
1.22	10	0	1,000	.03	93.46
All other grades (724 grades).....			132,125	4.15	.....

The reports by grades were satisfactory for a total of over three million tons of mixed fertilizer, or about two-thirds of the total reported as manufactured during 1917. These figures may be considered sufficiently complete to be indicative of the general situation. Table XI shows that 218 grades were manufactured in quantities of 1,000 tons or more. These 218 grades comprised over 95 per cent of the total mixed fertilizer produced, while the remaining 4 and a fraction per cent of the mixed fertilizer was distributed in small quantities among 724 grades. Thirteen grades carried about one-half of the fertilizer business, the leading ones being 2–10–0, 3–9–0, 2–12–0, 2–8–2, 4–8–0, 3–8–0, 2–10–2, 4–10–0, 5–10–0, 1–10–0, 3–8–2, 3–10–0, and 1–8–1. It will be noted that only four of this list contain any potash, namely, grades, 2–8–2, 2–10–2, 3–8–2, and 1–8–1, which had only 1 or 2 units of potash. This condition was primarily due to the scarcity and high price of potash.

The most significant fact brought out by the tabulation is that the number of grades in the market could be reduced to less than one-fourth of the present number without cutting down the production by more than 4 per cent of its present quantity.

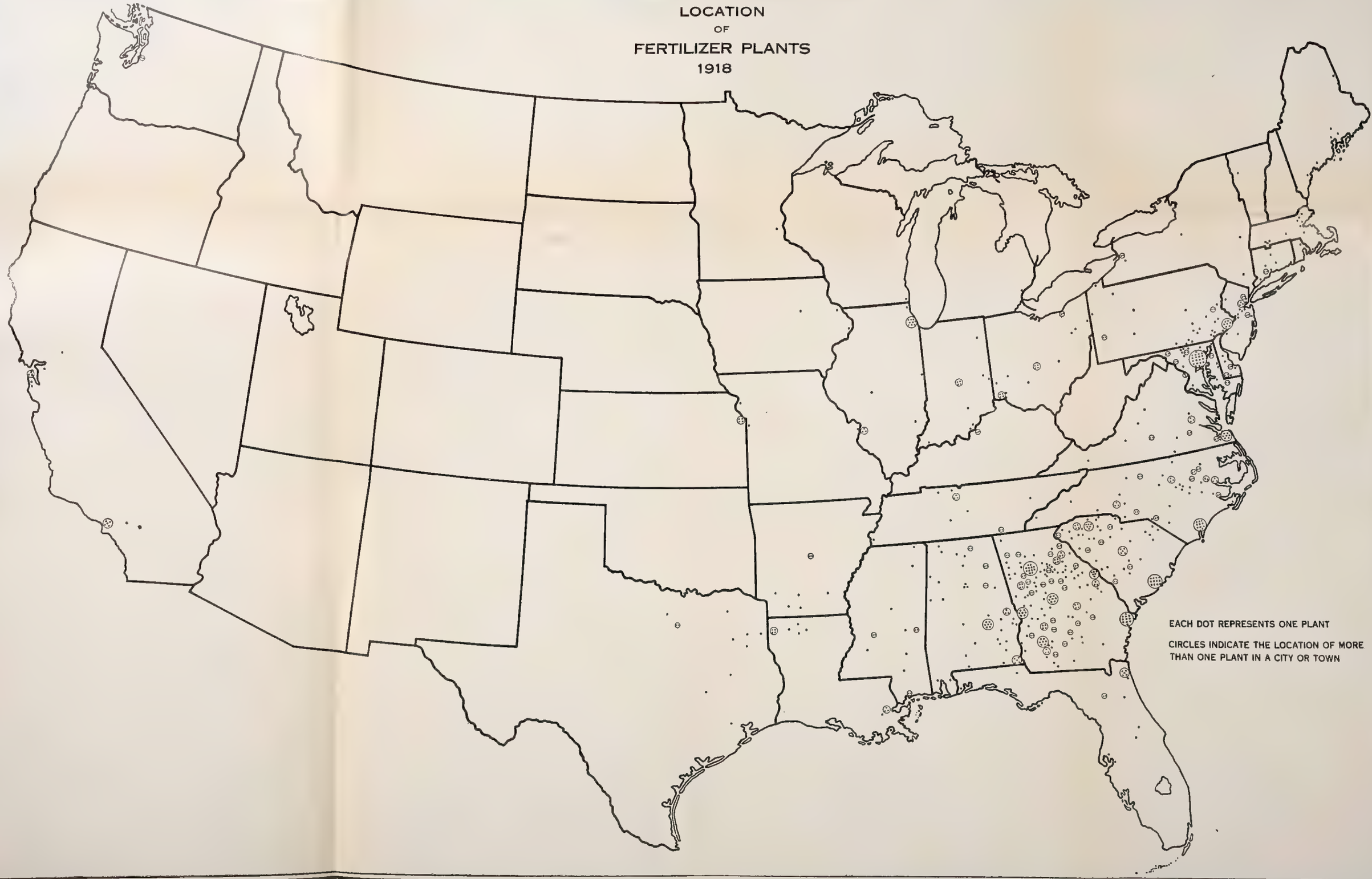
There is a strong feeling in the industry that it would be helpful if the number of grades manufactured were restricted in some way. A trade agreement along that line would be advantageous, not only to the fertilizer manufacturers, but also to the farmers. A large number of different grades of fertilizer are produced which differ so slightly from each other that no perceptible difference in their effect on plants can be expected.

STOCKS.

The schedule sent to fertilizer manufacturers included a question referring to stocks of different materials on hand on January 1, 1917, January 1, 1918, and June 30, 1918. This information was asked for when the end of the war was not in sight and when it was proposed to have a periodical inquiry every three months or every six months. The main purpose of the inquiry was to ascertain whether the stocks of any ingredient were getting low, in order to take measure to avoid the shortage, and, on the other hand, to see whether any materials were being unduly hoarded by some firms at the expense of other firms. Since there is no immediate prospect of continuing the periodical reports, the information on stocks loses much of its value. It is, however, appended here (Table XII) because it may be of some interest to the users of this bulletin.

The stocks on hand on June 30, 1918, were much lower in nearly every case than they were on January 1 of either of the years 1917 and 1918, a natural result of the fact that most of the production and sales of fertilizer take place in the first half of the year and that,

LOCATION OF FERTILIZER PLANTS 1918



EACH DOT REPRESENTS ONE PLANT

CIRCLES INDICATE THE LOCATION OF MORE THAN ONE PLANT IN A CITY OR TOWN

9
68

COMMERCIAL FERTILIZER

PRODUCTION DURING YEAR ENDING JUNE 30

1918

CIRCLES VARY IN SIZE WITH PRODUCTION

QUANTITIES ARE SHOWN IN THOUSANDS OF TONS

therefore, the stocks on June 30 are at a low ebb. One of the items worth noting in connection with the stocks is the increase in the stock of potash in 1918 as compared with 1917. The production of potash in this country had increased decidedly and the stocks on hand were much larger than a year earlier. The stocks of sodium nitrate were greater in January, 1918, than in January, 1917, but the stocks of ammonium sulphate had declined and the stock of cyanamid was very low owing to the fact that cyanamid was practically all requisitioned by the Ordnance Department. The supply of tankage and of dried blood was lower in 1918 than in 1917, owing to the great demand for these materials as feed. On the other hand, cottonseed meal was represented by a larger stock in 1918 than in 1917.

TABLE XII.—*Stocks of mixed fertilizer and of fertilizer materials reported by fertilizer manufacturers.*

[2,000-pound tons.]

Kind of material.	Jan. 1, 1917.	Jan. 1, 1918.	June 30, 1918.	Kind of material.	Jan. 1, 1917.	Jan. 1, 1918.	June 30, 1918.
Mixed fertilizer	654,217	644,453	270,327	Nitrogenous materials:			
Pyrites	238,085	233,251	203,070	Sodium nitrate	55,782	104,818	47,488
Sulphuric acid	79,566	97,323	99,712	Ammonium sulphate	24,591	22,880	32,786
Sulphur	11,357	47,393	45,147	Cyanamid	19,272	5,730	1,525
Agricultural lime	6,834	8,086	6,336	Nitrate of lime	129	348	4
Agricultural salt	1,260	411	679	Ammonium phosphate	1,911	1,507	2,606
Phosphatic materials:				Tankage—			
Acid phosphate	1,207,171	1,434,900	742,929	Animal tankage (high grade)	67,954	43,993	44,090
Phosphate rock	230,905	315,175	271,012	Animal tankage (low grade)	35,131	26,650	18,540
Steamed ground bone	15,047	18,970	24,260	Garbage tankage	21,051	18,407	18,380
Raw bone	20,001	17,625	16,172	Tankage (n.o.s.)	2,212	1,343	664
Basic slag	673	261	235	Dried blood	17,499	15,353	10,821
Bone black	393	134	163	Cottonseed meal	62,446	107,266	60,093
Bone ash	43	33	33	Fish scrap (dried)	22,456	16,649	6,517
Other phosphatic materials	21	153	109	Fish scrap (acidulated)	10,753	7,857	5,949
Potash materials:				Castor bean pomace	5,671	12,095	4,471
Potassium sulphate	3,785	9,734	5,668	Hair	1,782	3,395	2,635
Potassium muriate	5,026	11,274	8,767	Hoof meal	1,470	2,466	2,042
Potassium nitrate	2,900	5,794	1,022	Hoofs and horns	342	442	335
Potassium carbonate	1,365	1,452	1,129	Hide scraps	163	541	413
Kainite	2,183	540	105	Leather scrap or meal	2,171	16,028	24,606
Manure salts	2,001	260	8	Wool waste	13	1,490	6,847
Nebraska potash	2,344	9,376	7,166	Tartar pomace	2,421	985	224
Cement dust	1,657	3,859	4,820	Peat (dry)	23	1,300	.....
Furnace and flue dust	893	1,920	995	Peat (wet)	1,000	500	500
Alunite	89	2,804	1,155	Peat (n. o. s.)	.....	357	274
Kelp dried	991	1,744	1,956	Peanut meal	211	1,079	219
Kelp ash	635	1,551	1,454	Natural guano	23,941	23,116	15,100
Kelp char	5	222	132	Base goods	179,283	230,464	89,162
Tobacco waste	16,672	19,511	13,533	Other nitrogenous materials	8,777	9,174	5,451
Wood ash and other plant ash	2,881	2,509	3,519	Filler	12,937	16,909	12,641
Manure ash	637	1,356	551	Other materials (n. o. s.)	2,889	2,284	2,753
Feldspar	73	713	707				
Sugar factory waste	708	1,169	2,132				
Other potash materials	9,600	9,087	12,835				

IMPORTS AND EXPORTS OF FERTILIZER INGREDIENTS OF IMPORTANCE IN FOREIGN TRADE.

Exports of phosphate rock, ground or unground, not acidulated.

HIGH-GRADE, HARD ROCK.

[2,240-pound tons.]

Destination.	1913	1914	1915	1916	1917	1918
Europe:	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Austria-Hungary	36,679	23,466				
Belgium	17,603	19,405				
Denmark	6,000	19,200	5,302	4,400		
France	8,400	3,200				
Germany	259,421	241,560	17,838			
Italy	8,775	10,210				
Netherlands	76,630	98,623	3,008			
Norway					3,104	8,356
Portugal		4,800	760	5,663		
Roumania	6,300					
Spain	12,399	20,493	3,421	5,920		
Sweden	23,495	14,720	9,566	28,195	11,559	13,551
United Kingdom—						
England	20,388	3,950	1,100			1,850
Scotland	4,320	9,708	5,010			
Ireland	13,765	6,000				
North America:						
British Honduras				5		
Canada	25			147	300	235
Mexico						10
West Indies—Cuba						45
Total	494,200	475,335	46,005	44,330	14,963	24,047
Recapitulation:						
Europe	494,175	475,335	46,005	44,178	14,663	23,757
North America	25			152	300	290
Europe:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Austria-Hungary	366,790	234,660				
Belgium	176,030	194,050				
Denmark	60,000	192,000	53,020	44,000		
France	84,000	32,000				
Germany	2,594,210	2,415,600	178,380			
Italy	87,750	102,100				
Netherlands	766,300	986,230	30,080			
Norway					31,040	61,210
Portugal		48,000	7,600	56,630		
Roumania	63,000					
Spain	123,990	204,930	34,210	59,200		
Sweden	234,950	147,200	95,660	267,753	115,858	99,677
United Kingdom:						
England	203,880	39,500	11,000			9,250
Scotland	43,200	97,080	50,100			
Ireland	137,650	60,000				
North America:						
British Honduras				50		
Canada	250			1,497	3,607	3,513
Mexico						108
West Indies—Cuba						615
Total	4,942,000	4,753,350	460,050	429,130	150,505	174,373
Recapitulation:						
Europe	4,941,750	4,753,350	460,050	427,583	146,898	170,137
North America	250			1,547	3,607	4,236

Exports of phosphate rock, ground or unground, not acidulated.

LAND PEBBLE.

[2,240-pound tons.]

Destination.	1913	1914	1915	1916	1917	1918
Europe:	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Austria-Hungary	.....	3,000	.....	.....	.....	.....
Belgium	106,998	129,537	11,800	.....	.....	4,769
Denmark	15,950	6,200	9,000	.....	.....	.....
France	113,014	159,927	5,900	14,537	14,536	10,438
Germany	104,470	122,316	5,550	.....	.....	.....
Italy	78,172	114,601	22,055	2,864	6,069	1,440
Netherlands	77,293	124,579	15,084	45,289	28,686	.....
Portugal	.....	4,800	.....	3,500	.....	.....
Spain	54,599	53,928	51,839	75,987	61,897	32,359
Sweden	18,960	34,400	.....	23,280	17,867	4,357
United Kingdom—						
England	83,584	104,840	49,642	34,656	16,794	28,115
Scotland	30,800	13,980	10,070	19,876	4,699	5,100
Ireland	22,300	40,400	33,400	31,483	17,540	4,000
North America:						
Canada	4,366	118	3,000	3,734	4,004	5,545
West Indies—Cuba	.....	.....	.....	.....	6,002	14,786
Asia—Japan	67,392	88,004	.....	.....	.....	.....
Oceania—British—Australia	.....	.....	5,132	.....	.....	.....
Total	777,898	1,000,630	222,472	255,206	178,094	110,909
Recapitulation:						
Europe	706,140	912,508	214,340	251,472	168,088	90,578
North America	4,366	118	3,000	3,734	10,006	20,331
Asia	67,392	88,004	.....	.....	.....	.....
Oceania	.....	.....	5,132	.....	.....	.....
Europe:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Austria-Hungary	.....	18,000	.....	.....	.....	.....
Belgium	641,985	765,210	67,300	.....	.....	16,930
Denmark	95,800	37,200	48,000	.....	.....	.....
France	674,284	943,603	35,400	52,977	38,648	41,774
Germany	607,224	694,146	30,300	.....	.....	.....
Italy	451,160	669,556	122,030	17,184	16,387	4,320
Netherlands	451,558	731,780	83,907	254,454	130,779	.....
Portugal	.....	28,800	.....	21,000	.....	.....
Spain	317,554	313,968	307,640	412,662	263,022	151,467
Sweden	113,760	206,400	.....	123,012	88,261	24,055
United Kingdom—						
England	493,111	621,740	293,622	172,244	47,765	119,502
Scotland	181,800	83,880	58,800	97,040	20,300	18,337
Ireland	119,100	219,600	186,100	154,037	63,531	15,000
North America:						
Canada	26,274	562	18,000	20,267	15,229	21,511
West Indies—Cuba	.....	.....	.....	.....	21,329	43,487
Asia—Japan	404,352	523,524	.....	.....	.....	.....
Oceania—British—Australia	.....	.....	25,660	.....	.....	.....
Total	4,577,962	5,857,969	1,276,759	1,324,877	705,251	456,383
Recaptulation:						
Europe	4,147,336	5,333,883	1,233,099	1,304,610	668,693	391,385
North America	26,274	562	18,000	20,267	36,558	64,998
Asia	404,352	523,524	.....	.....	.....	.....
Oceania	.....	.....	25,660	.....	.....	.....

Imports of nitrate of soda from Chile, 1909 to 1918, inclusive.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Tons.	*Dollars.*		*Tons.*	*Dollars.*
1909	329,124	11,296,083	1914	561,209	17,808,763
1910	538,119	16,225,296	1915	577,120	16,355,595
1911	528,435	16,244,812	1916	1,067,005	31,911,384
1912	475,560	15,123,210	1917	1,261,659	44,231,240
1913	573,773	19,942,419	1918	1,606,498	70,103,459

Value of imports of bones, hoofs, and horns, unmanufactured.

Origin.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Europe:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Austria-Hungary	1,134	8,287	10,359	892	597	53	157			
Belgium	61,258	75,523	94,622	65,361	51,837	31,414				
Denmark				7	3		10			
France	14,997	28,788	10,791	22,454	10,339	15,836	3,389	19,262	2,112	4,134
Germany	46,209	49,874	103,397	73,187	55,783	37,693	4,633	57		
Greece							1,551			
Italy	80	110		2,870	318	1,313	55	2,287	12	31,890
Netherlands	2,477	4,092	1,965	528	1,316	867	1,017			
Norway		10			5					
Russia in Europe			188	131	64	98				
Spain		8,629	8,444					98		
Sweden					10					
Switzerland				4	63					
United Kingdom—										
England	140,869	222,878	170,252	114,718	147,512	140,103	112,602	107,987	85,183	45,723
Scotland	326	10	123	140	1,264	193	12	56		304
North America:										
Bermuda		11,813			5					
Canada	94,949	96,524	90,038	87,565	108,518	142,850	126,293	131,073	189,016	250,660
Central American States—										
Costa Rica	568	606	283	211	180		492			150
Guatemala		52	514	575	537	590	4,100	26	3	
Honduras		2	2	10			35	10		
Nicaragua	155	63			147	100				
Panama	70	580	675	957	1,326	888	1,691	1,025	3,887	4,734
Salvador	154		867		177	182	227	100		
Mexico	40,447	43,085	57,205	67,632	101,714	69,238	77,068	166,055	99,595	88,934
Newfoundland and Labrador	557	225	659	419	263	586	485	116	279	113
West Indies—										
British—										
Barbados				30					5	
Jamaica	209	174		105				165	209	87
Trinidad and Tobago			45		153	1,379	2,059	607	43	
Other British						21	29	21		5
Cuba	38,203	45,567	44,664	43,811	37,205	48,605	44,666	43,667	50,982	47,748
Danish								4		
Dominican Republic					36			84	98	
Dutch			347	1,063	7,596	3,436	1,208	1,472	32	
Haiti							2,302	1,143	485	
Santo Domingo			130	48						
South America:										
Argentina	225,100	420,837	506,624	493,797	314,866	469,077	450,441	320,725	398,893	670,944
Brazil				133	892	360	7,940	2,789	2,373	5,100
Chile	10						1,260	190	13,040	

Colombia	1,617	603	1,063	335	650	2,001	640	747	1,558	4,253
Ecuador				68					2,174	
Guiana—										
British					21					
Dutch				70						
Peru							219		688	
Uruguay	106,037	48,021	66,996	55,716	38,529	75,304	49,110	49,513	110,401	160,006
Venezuela	160	460	1,552	2,722	2,992	6,144	4,750	5,069	11,271	7,132
Asia:										
Aden	4	25				6			973	333
China	559	353	262	1,842	73	267	359	6,442	2,062	
East Indies—										
British—										
British India	35		5	299	15	4,903	7,287	4,813		
Straits Settlements		10	2							
Other British			2							
Dutch	60	61					401		371	14
Hongkong	583	473	617	626	548	496	758	760	3,366	4,626
Japan	62	2	52	39	276		67		632	
Russia in Asia				70		206	74			
Siam								539		
Turkey in Asia						7				
Oceania										
British—Australia				115		7,162	164		217	34,659
French		75								
Philippine Islands	5	5	30	103	50	15	25	33	65	
Africa:										
British Africa—										
West								220		
South	37	4	18			72		41	1,488	12,997
East	426	90	75			1				
Egypt			1,056		13			46		
French Africa							3,867		6,000	
Portuguese Africa							30		31	
Total	777,357	1,067,911	1,168,924	1,038,653	885,893	1,061,466	911,473	867,242	987,544	1,374,546
Recapitulation:										
Europe	267,350	398,201	395,141	280,292	269,111	227,570	123,426	129,747	87,307	82,051
North America	175,312	198,691	195,429	202,426	257,857	267,875	260,655	345,568	344,634	392,431
South America	332,924	469,921	576,235	552,841	357,950	552,886	514,360	379,033	540,398	847,435
Asia	1,303	924	940	2,876	912	5,885	8,946	12,554	7,404	4,973
Oceania	5	80	30	218	50	7,177	189	33	282	34,659
Africa	463	94	1,149		13	73	3,897	307	7,519	12,997

Value of exports of bones, hoofs, horns, and horn tips, strips, and waste.

Destination.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Europe:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Austria-Hungary		205								
Belgium	56,045	12,384	36,105	24,733	12,148	9,136	37			
Denmark	134	103	52	92	294	167	183	1,620	655	
France	28,518	15,913	5,404	21,966	24,790	3,241	2,900	14,715	8,985	
Germany	6,522	3,387	11,276	8,365	3,423	6,725				
Gibraltar	45									
Italy	29,789	24,896	11,498	18,034	41,168	11,383	1,060	2,579	1,206	
Netherlands	3,211	2,300	9,682	10,126	15,817	6,751	1,265		8	
Norway									35	
Russia (in Europe)	450	450	310	1,758	410		300	1,772		
Spain	68	290	195						525	
Sweden				59		155		132		
Switzerland							50	10		
United Kingdom—										
England	45,994	46,117	36,840	22,950	28,723	24,617	9,082	13,944	9,186	
Scotland	50			45		120	140		90	
North America:										
Bermuda	72	49			154	7	36	26	175	
British Honduras	3	14	9		171			42	65	
Canada	33,087	16,530	4,315	9,853	7,587	7,607	2,413	9,865	41,492	
Central American States—										
Costa Rica	200	106	760	60		47	328	7	207	
Guatemala				8				279	127	
Honduras	2		11		3	15	39	104	70	
Nicaragua			19		20		4	181	188	
Panama	774	738	121	15	267	64	81	622	727	
Mexico	2,411	766	463	293	86	2	9	2,302	14,640	
Newfoundland and Labrador				27		26		140	648	
West Indies:										
British—										
Barbados	3,158	2,400						9	27	
Jamaica			8				8	227	129	
Trinidad and Tobago			2,015				6	83	13	
Other British				22	26		16	118	150	
Cuba	293	1,242	1,255	851	1,418	2,105	1,891	3,395	5,660	
Danish	230						60	16	58	
Dominican Republic					4	20	130	911	4,307	
Dutch		99		21			3	27	20	
French		6						22		
Haiti		27	55				12	139	319	
Santo Domingo	1,318	659	36	135						
South America:										
Argentina		10					35	1,682	5,097	
Brazil						6	899	1,408	2,445	

Colombia	316			19	952		34	958	1,999	
Ecuador		1,065		22	242	37	27	188	1,101	
Guiana (British)		37						5	68	
Peru							44	12	808	
Venezuela				38	166			102	591	
Asia:										
China						350		36	911	
East Indies—										
British—										
British India			75				16		126	
Hongkong	110	760	150		190	152		3,700		
Japan	19,610	17,154	26,110	38,077	41,678	33,160	24,147	30,175	30,755	
Russia (in Asia)		700								55
Oceania:										
British—Australia	218			13		48	984	688	1,416	
New Zealand		500		21			282	43	11	
Philippine Islands		1,371	5,403	4,406	544	2,890	4,262	11,604	3,918	
Africa—British:										
West									637	
South		93						15		
Total	232,628	150,371	152,167	162,009	180,281	108,831	50,971	105,094	143,281	
Recapitulation:										
Europe	170,826	106,045	111,362	108,128	126,773	62,295	15,017	35,285	20,670	
North America	41,548	22,636	9,067	11,285	9,736	9,893	5,036	18,549	69,114	
South America	316	1,112		79	1,360	43	1,234	4,934	15,164	
Asia	19,720	18,614	26,335	38,077	41,868	33,662	24,163	33,976	32,279	
Oceania	218	1,871	5,403	4,440	544	2,938	5,528	12,335	5,392	
Africa		93						15	642	

Value of imports of dried blood.

Origin.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Europe:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Austria-Hungary		13,848	19,973	7,107		10,396				
Belgium		8,048	68,750	2,265		93,621	7,473			
Denmark			904							
France		32	11,557			52			24	
Germany	842	114	6,941	6,272	8,668	18,209	359			
Netherlands			2,913	3,661						
United Kingdom—										
England	64,177	36,794	76,555	61,049		80,940	34,114	10,858		22,370
Scotland		12,974	18,093	12,068		17,074	2,437			883
North America:										
Canada	2,381	4,244	1,612		7,181	6,158	2,737	5,157	144	2,729
Mexico	4,447	8,248	6,953	9,096	3,088	7,436	25,065			1,990
West Indies—Cuba		1,425								
South America:										
Argentina	11,478	112,875	189,733	67,609	25,496	96,373	63,719	95,826	313,785	321,524
Chile										300
Uruguay		7,161	6,834	4,179	2,376	12,751	10,535	27,515	50,803	107,123
Venezuela							127	350		1,154
Asia:										
China							480			
Japan										500
Oceania:										
British—Australia	8,380	15,824	35,880	41,949	33,336	48,806	80,152	51,806	24,699	4,125
New Zealand								4,788		
Africa—Egypt								300		
Total	91,705	221,587	446,698	215,255	80,145	391,816	227,198	196,600	389,455	462,703
Recapitulation:										
Europe	65,019	71,810	205,686	92,422	8,668	220,292	44,383	10,858	24	23,253
North America	6,828	13,917	8,565	9,096	10,269	13,594	27,802	5,157	144	4,719
South America	11,478	120,036	196,567	71,788	27,872	109,124	74,381	123,691	364,588	430,106
Asia							480			500
Oceania	8,380	15,824	35,880	41,949	33,336	48,806	80,152	56,594	24,699	4,125
Africa								300		

Imports of sulphur ore, as pyrites, or sulphuret of iron, containing in excess of 25 per cent of sulphur.

[2,240-pound tons.]

Origin.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Europe:	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Germany						1,200				
Portugal	71,839	86,264	117,996	117,914	118,732	102,150	57,109	46,351	16,475	2,700
Spain	545,448	601,536	742,758	840,229	814,534	638,711	687,812	1,207,323	747,866	596,583
United Kingdom—England						16				1,959
North America:										
Canada	43,882	39,500	29,977	37,103	31,293	79,141	99,738	120,896	171,268	205,163
Newfoundland and Labrador			3,548			1,335				3,670
West Indies—Cuba		2,202		50		2,200				
South America—Brazil						7,381				
Asia—Japan	100		2					471		
Total	661,269	729,502	894,281	995,296	964,559	832,134	844,659	1,375,041	935,609	810,075
Recapitulation:										
Europe	617,287	687,800	860,754	958,143	933,266	742,077	744,921	1,253,674	764,341	601,242
North America	43,882	41,702	33,525	37,153	31,293	82,676	99,738	120,896	171,268	208,833
South America						7,381				
Asia	100		2					471		
Europe:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Germany						3,354				
Portugal	244,970	291,083	391,375	390,969	392,296	333,978	189,710	151,455	53,425	7,700
Spain	2,064,276	2,197,613	2,609,457	3,388,029	3,632,392	2,966,682	3,531,048	6,489,892	5,170,447	3,709,368
United Kingdom—England						149				6,638
North America:										
Canada	152,467	131,121	91,392	140,202	86,948	312,575	386,491	473,625	632,041	765,429
Newfoundland and Labrador			15,840			2,410				33,200
West Indies—Cuba		6,888		250		21,230				
South America—Brazil						54,957				
Asia—Japan	500		25					6,652		
Total	2,462,213	2,626,705	3,108,089	3,919,450	4,111,636	3,695,335	4,107,249	7,121,614	5,855,913	4,522.335
Recapitulation:										
Europe	2,309,246	2,488,696	3,000,832	3,778,998	4,024,688	3,304,163	3,720,758	6,641,337	5,223,872	3,723,706
North America	152,467	138,009	107,232	140,452	86,948	336,215	386,491	473,625	632,041	798,629
South America						54,957				
Asia	500		25					6,652		

GOVERNMENT PUBLICATIONS PERTAINING TO FERTILIZERS.

NOTE.—The following publications were all issued by the United States Department of Agriculture unless otherwise indicated.

GENERAL.

Agricultural production for 1919. Secretary Circ. 125. 27 p. 1919. "Fertilizers," p. 23.

Beavers, J. C. Farm practice in use of commercial fertilizers in South Atlantic states. Farmers' Bul. 398. 24 p. 1910.

Commercial stocks of fertilizer and fertilizer materials in the United States as reported for October 1, 1917, Secretary Circ. 104. 12 p. 1918.

Farm fertilizers. Plant Industry. B. P. I. 631. No. "A"–72. 8 p. 1911.

Farm fertilizers. Plant Industry. B. P. I. 692. No. "A"–77. 14 p. 1911.

Fertilizer. War Industries Board. Price fixing bulletin, no. 8. Mimeographed. 33 p. November, 1918.

Fry, William H. Identification of commercial fertilizer materials. Dept. Bul. 97. 13 p. 1914.

Gardner, F. D. Fertility of soils as affected by manures. Soils Bul. 48. 50 p. 1908.

Gardner, F. D. Manurial requirements of Leonardtown loam soil of St. Mary County, Maryland. Soils Circ. 15. 13 p. 1905.

Gardner, F. D., and Bonsteel, F. E. Manurial requirements of the Cecil silt loam of Lancaster County, South Carolina. Soils Circ. 16. 7 p. 1905.

Gardner, F. D., and Bonsteel, F. E. Manurial requirements of the Portsmouth sandy loam of the Darlington Area, South Carolina. Soils Circ. 17. 10 p. 1905.

Loew, Oscar. The physiological rôle of mineral nutrients in plants. Plant Industry Bul. 45. 70 p. 1903.

McBryde, J. M. Fertilizers for cotton. Farmers' Bul. 14. 31 p. 1894.

Mercier, W. B., and Savely, H. E. Farm manures and fertilizers. States Relations Service. S. R. S. Doc. 30. 14 p. 1916.

Pogue, Joseph E. The mineral industries of the United States: fertilizers: an interpretation of the situation in the United States. Smithsonian Institution, Bul. 102, pt. 2. 22 p. 1917.

Report on fertilizer industry, 1916. Federal Trade Commission. xx+269 p., 10 pl. 1916. (Same issued as S. Doc. 551, 64th Cong., 1st sess.)

Ross, William H. Fertilizers from industrial wastes. Yearbook 1917, p. 253–263. Sep. 728.

Ross, William H. The use of radioactive substances as fertilizers. Dept. Bul. 149. 14 p. 1914.

Schroeder, J. P. Fertilizer value of city waste. Part II, Utilization of garbage waste. Reprint from the Journal of industrial and engineering chemistry, v. 9, no. 5, p. 513. May, 1917.

Skinner, J. J., and Beattie, J. H. City street sweepings as a fertilizer. Soils Circ. 66. 8 p. 1912.

Turrentine, J. W. Preparation of fertilizer from municipal waste. Yearbook 1914, p. 295–310. 2 fig. Sep. 643.

Voorhees, Edward B. Commercial fertilizers, composition and use. Farmers' Bul. 44. rev. ed. 37 p. 1906.

White, H. C. Manuring of cotton. Farmers' Bul. 48. 16 p. 1897.

Whitney, Milton. Fertilizers for corn soils. Soils Bul. 64. 31 p. 1910.

Whitney, Milton. Fertilizers for cotton soils. Soils Bul. 62. 24 p. 1909.

Whitney, Milton. Fertilizers for potato soils. Soils Bul. 65. 19 p. 1910.

Whitney, Milton. Fertilizers for wheat soils. Soils Bul. 66. 48 p. 1910.

Whitney, Milton. Fertilizers on soils used for oats, hay, and miscellaneous crops. Soils Bul. 67. 73 p. 1910.
Woods, A. F. Fertilizers for special crops. Yearbook 1902, p. 553–572.
Woods, A. F. The relation of nutrition to the health of plants. Yearbook 1901, p. 155–176. pl. II–VIII. Sep. 225.

AMMONIA.

Boykin, E. B. Comparative value of whole cotton seed and cottonseed meal in fertilizing cotton. Farmers' Bul. 286. 14 p. 1907.
Brown, Frederick W. The sources of our nitrogenous fertilizers. Yearbook 1917. p. 139–146. Sep. 729.
Gale, H. S. Our mineral supplies—nitrates. U. S. Geol. Surv. Bul. 666–Z. 4 p. [1917.]
Gilbert, Chester G. Sources of nitrogen compounds in the United States. Smithsonian Institution, Pub. 2421. [2]+12 p. 1916.
Lathrop, Elbert C. The nitrogen of processed fertilizers. Dept. Bul. 158. 14 p. 1914.
Method of sale of nitrate of soda to farmers by the United States Government. Sec. Circ. 78. 11 p. 1918.
Schreiner, Oswald, and Skinner, J. J. Nitrogenous soil constituents and their bearing on soil fertility. Soils Bul. 87. 84 p. 1912.
Scott, Ernest Kilburn. The manufacture of nitrates from the atmosphere. Smithsonian Institution Pub. 2291. [1]+359–384 p., il., 1 pl., 2 p. of pl. 1914. (From Report, 1913.)
Stuntz, S. C., comp. Reference list of electric fixation of atmospheric nitrogen and use of calcium cyanamid and nitrate on soils. Soils Bul. 63. 89 p. 1910.
Turrentine, J. W. Nitrogenous fertilizers obtainable in the United States. Dept. Bul. 37. 12 p. 1913.
Turrentine, J. W. The fish-scrap fertilizer industry of the Atlantic Coast. Dept. Bul. 2. 50 p. 6 pl. 1913.
Turrentine, J. W. Utilization of fish waste of the Pacific Coast for fertilizer. Dept. Bul. 150. 71 p. 6 pl. 1915.

LIME.

Loew, Oscar, and May, D. W. The relation of lime and magnesia to plant growth. Plant Industry Bul. 1. 53 p. 3 pl. 1901.
Loughlin, G. F. Lime in 1916. U. S. Geol. Surv., Mineral resources of the United States, 1916, pt., 2:4, p. 433–462.
Loughlin, G. H. Our mineral supplies—limestone and lime. U. S. Geol. Surv. Bul. 666-R. 6 p. [1917].
Shorey, Edmund C. The principles of the liming of soils. Farmers' Bul. 921. 30 p. 5 fig. 1918.
Stone, R. W. Our mineral supplies—gypsum. U. S. Geol. Surv. Bul. 666–E. [1917]. 3 p.
Wheeler, H. J. The liming of soils. Farmers' Bul. 77. Rev. ed. 23 p. 1905.

MANGANESE.

Hewett, D. F. Our mineral supplies—manganese. U. S. Geol. Surv. Bul. 666–C. [1917]. 12 p.
Skinner, J. J., and Reid, F. R. The action of maganese under acid and neutral soil conditions. Dept. Bul. 441. 12 p. 1916.
Sullivan, M. X., and Robinson, W. O. Manganese as a fertilizer. Soils Circ. 75. 3 p. 1913.

MANURE.

Beal, W. H. Barnyard manure. Farmers' Bul. 192. 32 p. 1904.

Brodie, D. A. Handling barnyard manure in eastern Pennsylvania. Farmers' Bul. 978. 24 p. 4 fig. 1918

White, H. C. Barnyard manure. Farmers' Bul. 192. 16 p. 1897.

PEAT.

Turp, James S. Peat in 1915. U. S. Geol. Surv., Mineral resources of the United States, 1915, pt. 2:34. 4 p.

PHOSPHORUS.

Stone, Ralph W. Phosphate rock in 1917 with notes on phosphorus. U. S. Geol. Surv., Mineral resources of the United States, 1917, pt. 2:3, p. 7–18.

Stone, R. W. Our mineral supplies—phosphate rock. U. S. Geol. Surv. Bul. 666–J. [1917] 4 p.

Waggaman, W. H., and Wagner, C. R. Analysis of experimental work with ground raw rock phosphate as a fertilizer. Dept. Bul. 699. 119 p. 1918.

Waggaman, William H. The manufacture of acid phosphate. Dept. Bul. 144. 28 p., 5 pl. 1914.

Waggaman, William H., and Fry, William H. Phosphate rock and methods proposed for its utilization as a fertilizer. Dept. Bul. 312. 37 p. 1915.

Waggaman, William H. Phosphate rock our greatest fertilizer asset. Yearbook 1917, p. 177–183. Sep. 730.

Waggaman, William H. The production and fertilizer value of citric-soluble phosphoric acid and potash. Dept. Bul. 143. 12 p. 1914.

Waggaman, William H. A report of the natural phosphates of Tennessee, Kentucky, and Arkansas. Soils Bul. 81. 36 p. 4 pl. 1912.

Waggaman, William H. Report on phosphate fields of South Carolina. Dept. Bul. 18. 12 p., 3 pl., 1 fig. 1914.

Waggaman, W. H. Review of phosphate fields of Florida. Soils Bul. 76. 23 p. 1911.

Waggaman, W. H. A review of phosphate fields of Idaho, Utah and Wyoming. Soils Bul. 69. 48 p. 1910.

Waggaman, William H. The utilization of acid and basic slags in the manufacture of fertilizer. Soils Bul. 95. 18 p. 1913.

POTASH.

Brown, Frederick W. Importance of developing our natural resources of potash. Yearbook 1916, p. 301–310. 3 fig. Sep. 717.

Cameron, Frank K. Possible sources of potash in United States. Yearbook 1912, p. 523–536. Sep. 611.

Cameron, Frank K. Potash from kelp. U. S. Dept. Agr. Rpt. 100. 122 p., xl pl. 1915. Atlas of 69 maps 1914.

Cushman, Allerton S. The use of feldspathic rocks as fertilizers. Plant Industry Bul. 104. 32 p. 1907.

Free, E. E. An investigation of the Otero Basin, New Mexico, for potash salts. Soils Circ. 61. 7 p. 1912.

Gale, Hoyt S. Our mineral supplies—potash. U. S. Geol. Surv. Bul. 666–N [1917] 4 p.

Mid-year statistics on production of potash. U. S. Geol. Surv., Press Bul. 379, p. 4. Sept. 1918.

Phalen, W. C. Potash salts 1915 with bibliography by W. C. Phalen, with simple tests for potash by W. B. Hicks. U. S. Geol. Surv., Mineral resources of the United States, 1915, pt. 2, p. 95–133.

Potash from kelp and alunite, sugar manufacture, cement, etc. U. S. Geol. Surv., Press Bul. 366, p. 3–4. May, 1918.

Potash, Domestic Production of, in 1918. U. S. Geol. Surv., Press Bul. 399, p. 1. February, 1919.

Ross, W. H. The extraction of potash from silicate rocks. Soils Circ. 71. 10 p. 1912.

Ross, William H., Merz, Albert R., and Wagner, C. R. The recovery of potash as a by-product from the cement industry. Dept. Bul. 572. 23 p. 1917.

Skinner, J. J., and Jackson, A. M. Alunite and kelp as potash fertilizers. Soils Circ. 76. 5 p. 1913.

Stockett, A. W. The potash situation, Bureau of Mines, War Minerals Investigations Series No. 2. 13 p. 1918.

Turrentine, J. W. The occurrence of potassium salts in the salines of the United States. Soils Bul. 94. 96 p. 1913.

Waggaman, William H. Alunite as a source of potash. Soils Circ. 70. 4 p. 1912.

Waggaman, William H. The production and fertilizer value of citric-soluble phosphoric acid and potash. Dept. Bul. 143. 12 p. 1914.

Waggaman, W. H., and Cullen, J. A. The recovery of potash from alunite. Dept. Bul. 415. 14 p. 1 fig. 1916.

Young, G. J. Potash salts and other salines in the Great Basin region. Dept. Bul. 61. 96 p. 8 fig. 1914.

SULPHUR.

Smith, Philip S. Our mineral supplies—sulphur. U. S. Geol. Surv. Bul. 666–B. [1917] p. 7–10.

Smith, Philip S. Sulphur, pyrite and sulphuric acid in 1916. U. S. Geol. Surv., Mineral resources of the United States, 1916, pt. 2:28, p. 403–432; 1917, pt. 2:4, p. 19–62.

Stone, R. W. Our mineral supplies—gypsum. U. S. Geol. Surv. Bul. 666–E. [1917] 3 p.

Waggaman, William H. The production of sulphuric acid and the proposed new method of manufacture. Dept. Bul. 283. 39 p. 1 fig. 1915.

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
10 CENTS PER COPY

NATIONAL AGRICULTURAL LIBRARY
1022415152